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XXIV. *Proposals for the Recovery of People apparently drowned.* By John Hunter, Esq. F. R. S.

R. Mar. 21,
1776. **H**AVING been requested by a principal member of the society, lately established for the recovery of persons apparently drowned, to commit my thoughts on that subject to paper; I readily complied with his request, hoping, that, although I have had no opportunities of making actual experiments upon drowned persons, it might be in my power to throw some lights on a subject so closely connected with the inquiries which, for many years, have been my favourite business and amusement. I therefore collected together my observations and experiments relative to the loss and recovery of the actions of life, and shewed them to a Society of which I am a member; who approved of them as new and curious, and unanimously recommended their being submitted to the judgement of this learned Body. The practice is new, and has furnished as yet few important and clear facts. If we judge of the question by our general knowledge of the animal œconomy, I am afraid, it is so imperfectly understood, that our reasoning from it alone could not be relied on: nevertheless, on a subject so interesting to humanity, we must not be idle; we must throw out our observations, and reason as well as we can
from

from the few *data* we have, in hopes that the subject, thus put fairly into the hands of the publick, may in time, by their united endeavours, become perfectly understood.

I shall consider an animal, apparently drowned, as not dead; but that only a suspension of the actions of life has taken place. This, probably, is the case in the beginning of all violent deaths, except those caused by lightning or electricity, by which absolute death may be produced instantaneously.

How a blow on the stomach causes death I have not been able to ascertain. In all those cases which have fallen under my observation, the concomitant circumstances have been such as also attend death caused by electricity; *viz.* a total and instantaneous privation of sense and motion without convulsions, and consequently without any succeeding rigor of muscles, totally differing in these circumstances from death, where the person is struck senseless by any injury done to the brain. I should consider the situation of a person drowned to be similar to that of a person in a trance. In both the action of life is suspended, without the power being destroyed; but I am inclined to believe, that a greater proportion of persons recover from trances than from drowning; because a trance is the natural effect of a disposition in the person to have the action of life suspended for a time; but drowning being produced by violence, the suspension will more frequently last for ever, unless the power of life is roused to action by some applications of art. That I

may more fully explain my ideas upon this subject, it will be necessary to state some propositions.

First, that so long as the animal retains the powers, though deprived of the action, of life, the cause of that privation may frequently be removed; but, when the powers of life are destroyed, the action ceases to be recoverable. Secondly, it is necessary to mention that I consider part of the living principle as inherent in the blood (*a*). The last proposition I have to establish is, that the stomach sympathizes with every part of an animal, and that every part sympathizes with the stomach; therefore, whatever acts upon the stomach as a cordial, or rouses its natural and healthy actions, and whatever affects it, so as to produce debility, has an immediate effect upon every part of the body. This sympathy is strongest with the vital parts. Besides this universal sympathy between the stomach and all parts of the body, there are peculiar sympathies; for instance, the heart sympathizes immediately with the lungs. If any thing is received into the lungs, which is a poison to animal life, such as the volatile part in the burning of charcoal, volatile vitriolic acid, and many other well known substances, the motion of the heart immediately ceases, much sooner than if the

(*a*) That the living principle is inherent in the blood, is a doctrine which the nature of this paper will not allow me at present to discuss; thus much, however, it may be proper to say, that it is founded on the results of many experiments. But it may be thought necessary here, to give a definition of what I call the living principle: so far as I have used that term in this paper, I mean, to express that principle which preserves the body from dissolution with or without action, and is the cause of all its actions.

trachea

trachea had been tied; and from experiments it appears, that any thing salutary to life, applied to the lungs, will restore the heart's action after it has been at rest some time.

I shall divide violent deaths into three kinds. First, where only a stop is put to the action of life in the animal; not, however, by any irreparable injury to a vital part. If this action is not restored in a certain time, it will be irrecoverably lost. The length of that time is subject to considerable variation; which probably depends on circumstances, we are at present unacquainted with. The second is, where an injury is done to a vital part: as, by taking away blood till the powers of action are lost, by a wound or pressure on the brain or spinal marrow; notwithstanding which, there remains sufficient life in the solids, if actions could be restored to the vital parts. The third is, where absolute death instantly takes place in every part, which is often the case in strokes of lightning; in the common method of killing eels, by throwing them on some hard substance, in such manner as that the whole length of the animal shall receive the shock at the same instant; and, as I believe, by a blow on the stomach; in all which cases the muscles remain flexible^(b).

(b) On the other hand, when an eel is killed by chopping it into a number of pieces, the powers of life are by those means roused into action; and, as every part dies in that active state, every part is found stiff after death. This explains the custom of cutting fish into pieces while yet alive, in order to make them hard, usually known by the name of crimping.

Now, the present consideration is, which of the kinds of violent death drowning comes under? I think, it comes under the first; and upon that ground I shall consider the subject.

The loss of motion in drowning seems to arise from the loss of respiration, and the immediate effects which this has upon the other vital motions of the animal; at least, this privation of breathing appears to be the first cause of the heart's motion ceasing; therefore, most probably, the restoration of breathing is all that is necessary to restore the heart's motion: for if a sufficiency of life still exists to produce that effect, we may suppose every part equally ready to move the very instant in which the action of the heart takes place, their actions depending so much upon it. What makes it very probable, that the principal effect depends upon air being thrown into the lungs, is, that children in the birth, when too much time has been spent after the loss of that life which is peculiar to the *fœtus*, lose altogether the disposition for the new life. In such cases there is a total suspension of the actions of life, the child remains to all appearance dead, and would die, if air were not thrown into its lungs, and the first principle of action by these means restored. To put this in a still clearer light, I will give the result of some experiments which I made, in the year 1755, upon a dog.

A pair of double bellows were provided, constructed in such a manner as by one action to throw fresh air into the lungs, and by another to suck out again the air which

had been thrown in by the former, without mixing them together. The muzzle of these bellows was fixed into the *trachea* of a dog, and by working them he was kept perfectly alive. While this artificial breathing was going on, I took off the *sternum* of the dog, and exposed the lungs and heart; the heart continued to act as before, only the frequency of its action was considerably increased. I then stopped the motion of the bellows, and the heart became gradually weaker, and less frequent in its contraction, till it left off moving altogether: by renewing my operation, the heart began again to move, at first very faintly, and with longer intermissions; but, by continuing the artificial breathing, the motion of the heart became again as frequent and as strong as before. This process I repeated upon the same dog ten times, sometimes stopping for five, eight, or ten minutes. I observed, that, every time I left off working the bellows, the heart became extremely turgid with blood, and the blood in the left side became as dark as that in the right; which was not the case when the bellows were working. These situations of the animal appear to me exactly similar to drowning.

The loss of life in drowned people has been accounted for, by supposing that the blood, damaged by want of the action of the air in respiration, is sent, in that vitiated state, to the brain and other vital parts; by which means the nerves lose their effect upon the heart, and the heart in consequence its motion. This, however, I am fully convinced is false: first, from the experiments on the
dog,

dog, in whose case a large column of bad blood, *viz.* all that was contained in the heart and pulmonary veins, was pushed forward, without any ill effect being produced; and next, from the recovery of drowned persons and still-born children, which, under those circumstances, never could happen, unless a change of the blood could take place in the brain, prior to the restoration of the heart's motion: therefore, the heart's motion must depend immediately upon the application of such air to the lungs, and not upon the effects which air has upon the blood, and which that blood has upon the vital parts. These are only secondary operations in the animal œconomy.

It frequently happens in the case of drowning, that assistance cannot be procured till a considerable time after the accident; every moment of which delay renders recovery more precarious, the chances of which are not only diminished in the parts where the first powers of action principally reside, but also in every other part of the body.

In offering my sentiments on the method of treating people who are apparently drowned, I shall lay before you, first, what I would recommend to have done; secondly, what I would wish might be avoided.

When assistance is called in, soon after the immersion, perhaps blowing air into the lungs may be sufficient to effect a recovery (*c*). But if a considerable time, such as

(*c*) Perhaps the dephlogisticated air, described by Dr. PRIESTLEY, may prove more efficacious than common air. It is easily procured, and may be preserved in bottles or bladders.

an hour, has been lost, it is most probable that this will not be sufficient; the heart, in all likelihood, will by this time have lost its nice connection with the lungs. It will, therefore, be proper to apply stimulating medicines, such as the vapour of volatile alkali, mixed with the air; which may easily be done, by holding spirits of harts-horn in a cup under the receiver of the bellows. I would advise the air and volatile alkali to be thrown in by the nose, if by both nostrils so much the better, as we know, that applications of this kind to the olfactory nerves rouse the living principle, and put the muscles of respiration into action, while some applications to the mouth rather depress than rouse, by producing sickness. If during this operation the *larynx* be gently pressed against the *œsophagus* and spine, it will prevent the stomach and intestines being too much distended by the air, and leave room for the application of more effectual *stimuli* to those parts. This pressure, however, must be conducted with judgement and caution, so that the *trachea* and the aperture into the *larynx* may both be left perfectly free. While this business is going on, an assistant should prepare bed-cloaths, carefully brought to the proper degree of heat. I consider heat as congenial with the living principle; increasing the necessity of action it increases action; cold, on the other hand, lessens the necessity, and of course the action is diminished; to a due proportion of heat, therefore, the living principle owes its vigour.

From observations and experiments it appears to be a law of nature in animal bodies, that the degree of heat should bear a proportion to the quantity of life; as life is weakened, this proportion requires great accuracy, while greater powers of life allow it greater latitudes (*d*).

I was led to make these observations by attending to persons who are frost-bitten; the effect of cold, in this instance, is that of lessening the living principle. The powers of action remain as perfect as ever, and heat is the only thing wanting to put these powers into action; yet this heat must at first be gradually applied, and proportioned to the quantity of the living principle; but, as life increases, you may increase the degree of heat. If this method is not observed, and too great a degree of heat is at first applied, the person or part loses entirely the living principle, and mortification ensues. This process invariably takes place with regard to men. The same thing, I am convinced, happens to other animals. If an eel, for instance, is exposed to a degree of cold, sufficiently intense to benumb him till the remainder of life in him is scarcely perceptible, keep him still in a cold of about 40° , and this small quantity of life will remain for a considerable time without diminution or increase; but, if he is put into about 60° , the animal will at first shew strong signs of returning life, but will die in a few minutes. Nor is this circumstance peculiar to the

(*d*) It is upon these principles that cold air is found of so much service to people who are much reduced by disease, as the confluent small-pox, fevers, &c. *viz.* diminishing heat in proportion to the diminution of life.

diminution

diminution of life by cold. The same *phenomena* take place in animals who have been very much reduced by hunger.

If a lizard, or snake, when it goes to its autumnal hiding place, is not sufficiently fat, the living powers become, before the season permits it to come out, very considerably weakened, and perhaps so much as not to be again restored. If those animals, in such a state, are exposed to the Sun's rays, or placed in any situation which, by its warmth, would give vigour to those of the same kind, which are possessed of a larger share of life, they will immediately shew signs of increased life, but quickly sink under the experiment and die; while others, reduced to the same degree of weakness, as far as appearances can discover, will live for many weeks, if kept in a degree of cold proportioned to the quantity of life they possess.

I observed many years ago, in some of the colder parts of this island, that, when intense cold had forced black-birds or thrushes to take shelter in out-houses, any of those that had been caught, and from an ill-judged compassion exposed to a considerable degree of warmth, died very soon. The reason of this I did not then conceive; but I am now satisfied, that it was owing, as in the other instances, to the degree of heat being increased too suddenly for the proportion of life remaining in the animal.

From these facts it appears, that warmth causes a greater exertion of the living powers than cold; and that an animal, in a weakly state, may be obliged by it to exert

a quantity of the action of life sufficient to destroy the very powers themselves. (c) The same effects probably take place even in perfect health. It appears, from experiments made in a hot room, which were read to this Society, that a person in health, exposed to a great degree of heat, found the actions of life accelerated so much as to produce faintness and debility.

If bed-cloaths are put over the person so as scarce to touch him, steam of volatile alkali, or of warm balsams and essential oils, may be thrown in, so as to come in contact with many parts of his body. It will certainly prove advantageous if the same steams can be conveyed into the stomach, as that seat of universal sympathy will by these means be roused. This may be done by a hollow *bougie* and a syringe; but this operation should be performed with all possible nimbleness, because the instrument, by continuing in the mouth, may produce sickness, an effect I should chuse to avoid. Some of the stimulating substances, which are of a warm nature, and have an immediate effect, may be thrown into the stomach in a fluid state; *viz.* spirits of hartshorn, peppermint water, juice of horse-raddish; as many others also, which produce a more lasting *stimulus*, as balsams and turpentine, such as are found to quicken the pulse of a man in health; but the quantity must be small, as they have a tendency to produce sickness. The same steam and substances should also be thrown up by the *anus*.

(c) It is upon this principle that parts mortify in consequence of inflammation.

The process recommended under the first head of treatment should still be continued; while that recommended under the second is put in practice, as the last is only an auxiliary to the first. The first, in many cases, may succeed alone; but the second without the first must, I think, always fail in cases where the powers of life are considerably weakened. Motion possibly may be of service, it may at least be tried; but, as it has less effect than any other of the usually prescribed *stimuli*, it should be the last part of the process (*f*). I would recommend the same care to the operator in regulating the proportion of every one of these means as I did before in the application of heat; possibly every one of them may have the same property of destroying entirely the feeble action which they have excited, if administered in too great a quantity; instead, therefore, of increasing and hastening the operations on the first signs of returning life being observed, as usually done, I should wish them to be lessened, that their increase afterwards may be graduated, as nearly as possible, by the quantity of powers as they arise. If the heart begins to move, I would lessen my application of air to the lungs, and with great attention observe when the muscles of respiration began to act, that, when they do, I might leave a great deal to them. I would by

(*f*) How far electricity may be of service, I know not; but it may, however, be tried, when every other method has failed. I have not mentioned injecting stimulating substances directly into the veins, though it might be supposed a proper expedient; because, in looking over my experiments on that subject, I found none where animal life received increase.

all means forbid bleeding, which, I think, weakens the animal principle, and lessens life itself, consequently lessens both the powers and dispositions to action. I would avoid introducing any thing into the stomach, which ordinarily produces *nausea* or vomiting, as that also will have a similar effect. I would avoid likewise throwing any thing in by the *anus*, which might tend to an evacuation that way, as every such evacuation also tends to lessen the animal powers; of course, I have avoided speaking of the fumes of tobacco, which always produce sickness or purging, according as they are applied.

Whoever is appointed by the society for the purposes of recovering drowned people, should have an assistant, well acquainted with the methods intended to be made use of; that, while the one is going on with the first and most simple methods, the other may be preparing other means, so that no time may be lost between the operations; and the more so, as the first will, in all cases, assist the second, and both together may often be attended with success, though each separately might have failed.

A proper apparatus also is as essentially necessary to the institution, a description of which I here annex. First, a pair of bellows, so contrived with two separate cavities, that by opening them, when applied to the nostrils or mouth of a patient, one cavity will be filled with the common air, and the other with air sucked out from the lungs, and by shutting them again, the common air will be thrown into the lungs, and that sucked

out of the lungs discharged into the room. The pipe of these should be flexible, in length a foot or a foot and a half, and at least three-eighths of an inch in width; by this the artificial breathing may be continued, while the other operations, the application of the *stimuli* to the stomach excepted, are going on, which could not conveniently be done, if the muzzle of the bellows were introduced into the nose. The end next the nose should be double, and applied to both nostrils. Secondly, a syringe, with a hollow *bougie*, or flexible *catheter*, of sufficient length to go into the stomach, and convey any stimulating matter into it, without affecting the lungs. Thirdly, a pair of small bellows, such as are commonly used in throwing fumes of tobacco up the *anus*.

I shall conclude this paper by proposing, that all, who are employed in this practice, be particularly required to keep accurate journals of the means used, and the degrees of success attending them; whence we may be furnished with facts sufficient to enable us to draw conclusions, on which a certain practice may hereafter be established.